Collaborative decision-making in METOC

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Individual Rationality = Sequential Interaction Uncertainty

- Classical Physics and Traditional Social Science based on **stable R**
- **Correspondence** between L concepts and physical objects in R
  - Game theory (VN&M, 1953)
  - Exchange theory (K&T, 1959; 1978)
  - Social learning theory (behaviorism+modeling; B,'71)
  - Polit. science (Marxism; central d.m.; consensus d.m.)
  - **Social measurement theory (x-validation; Campbell, 1959)**
  - Classical mechanics (Planck, 1905; EPR, 1935)
  - Machine learning (Brooks, 1990)
  - Truth is accessible to mind (Pinker, 1990)
- Emotion replaced w/rational constructs (e.g., game configurations)
  - The cost of emotion is an inefficient executive (Minsky, 2001)
- LP: convergence -> best decisions and agreement
- **H (LP): collaboration works best under cooperation**

Problems w/cooperation & CC's

- Hitler: sidelined superior AC + pilots
- Korea: Soviet "welded wing" GIC v. NATO "loose deuce" (Randall, 1997)
- After captains feigned incapacity, 25% of first officers failed to intervene (Foushee & Helmreich, 1988)
- Others: Shuttle explosion (1985); USS Vicennes & Iranian airbus (1989); AWACS authority to fire BVR, visual contact -> Sudanese airliner & later 2 Blackhawks down w/malfunctioning IFF (1994)

When cooperation works best

- For well-defined problems

When cooperation does not work

- Social loafing (Latane, 1981)
- Asymmetric *I* (e.g., deception: WTC 9/11; Enron -> $20 billion loss)
- Corruption (Lawless, 2001)

Benefits of Competition

	1	2	3	4	5	6	7
1. SW	1.0						
2. H	-.72**	1.0					
3. E	.73**	-.66**	1.0				
4. pc's	.93**	-.70**	.78**	1.0			
5. web	.61*	-.37	.74**	.71**	1.0		
6. EF	.88**	-.79**	.70**	.84**	.48	1.0	
7. CPI	.81**	-.72**	.73**	.89**	.60*	.82**	1.0

- **Competition incr. SW, H, EF, less corruption**
- Notes (CM: *E* use among nations; Lawless & Castelao, 2001):

SW Scientific Wealth (May, 1997, Science)
H Poor Health (infant mortality per 1000 births, World Bank)
E Energy consumption is Energy kg OE per capita, World Bank
pc's personal computers per 1,000 capita, World Bank
web Internet web hosts per 10,000 capita, World Bank
EF Economic Freedom, Cato Institute with Heritage Predation
CPI Corruption Perceptions Index, Transparency International

Competition => Bistable *R* + Conjugate Interaction *U*

Aeschylus (struggle -> wisdom; court -> justice)
Copernicus (the transformed perspective)
Descartes (mind-body split)
Newton (actual versus perceived inertia)
Bergson + James (perceived R ≠ experience)
Einstein (1909: wave-particle duality)
Heisenberg + Bohr (uncertainty in atomic χ's)
Bohr (uncertainty in social χ's = actor v spectator)
Lewin (1951: observed group a ≠ perceived group a)
Arrow (1951: rat individual preferencess ≠ rat group prefs)
Poincare (1952): Educ. => K is log. + organized ≠ discovery
Allport (1962: discontinuity betw individual and group)
Kahneman & Tversky (1981: frames of reference)
Kelley (1979: given matrix ≠ effective matrix)

Campbell (1996):

- **» x-validation fails w/incommensurability**
- **» => multiple *R*'s**

Bistable Reality

1. Multiple convergences => multiple cultures (Bohr, 1955)

2. Observers see faces (culture A) or vase (culture B), but not both simultaneously

3. Promotes disagreement during decision making

Social Uncertainty Relations

- We are actors or spectators (Bohr, 1955)
- M's -> Convergence to reduce U ->
  + Ingroup-Outgroup U
- Let $\Delta a = \Delta I / \Delta t$ = action uncertainty;
- Let ΔI = information uncertainty;

$$\Delta a \Delta I \approx c \qquad (1)$$

Bistable R difficult to understand b/c meaning comes from convergence into mutually exclusive cultural belief A or B
(Lawless, 2001)

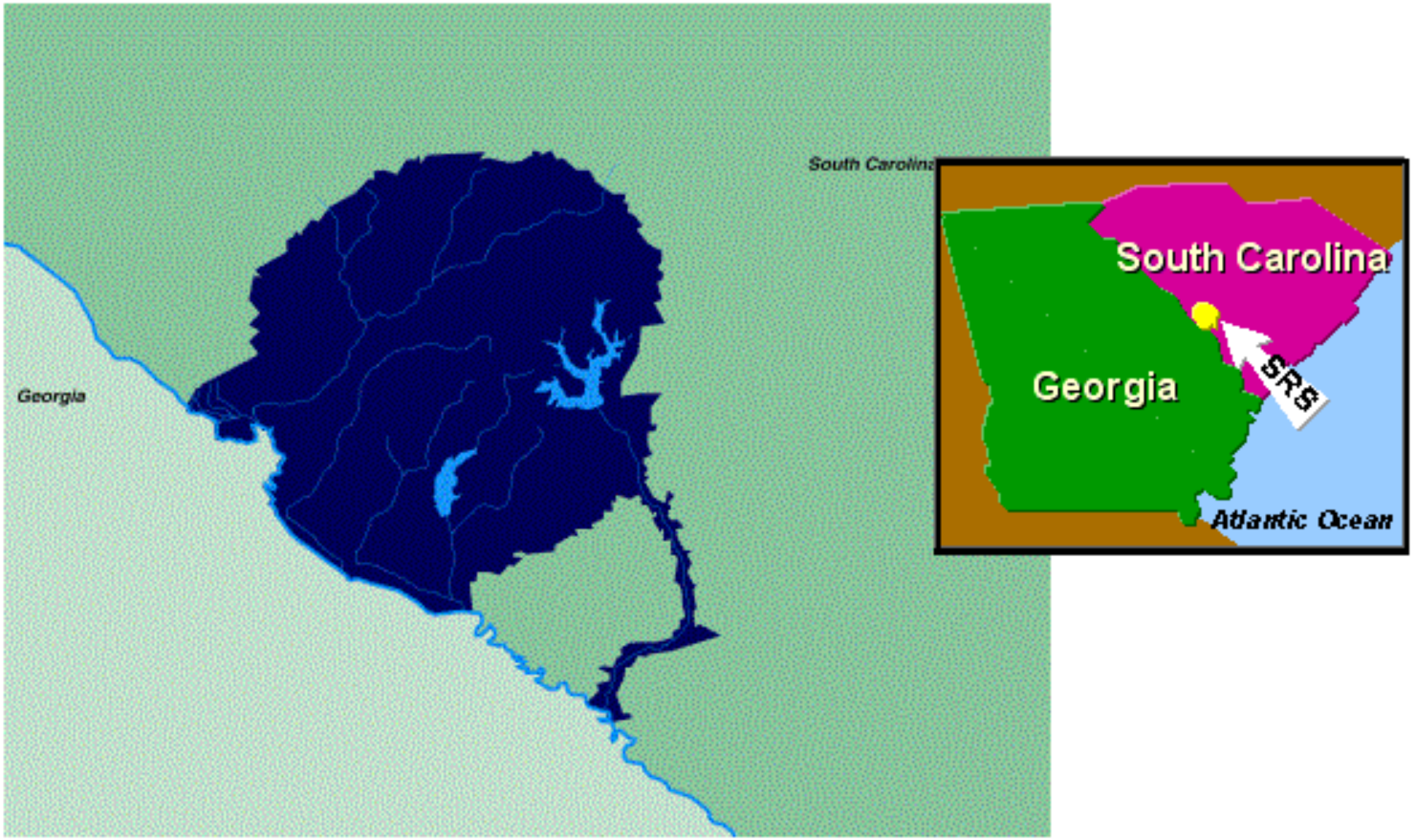
Solving $\Delta a \Delta I \approx c$

- Case i: $\Delta I \rightarrow 0\ (K)$, $\Delta a \rightarrow \infty$
  - **USAF (*E* availability $\propto$ SME $\propto$ *B* $\neq$ *K*)**
  - Math (perc'd math skills $\propto$ S.E. $\neq$ math scores)
- Case ii: $\Delta a \rightarrow 0$, $\Delta I \rightarrow \infty$
  - Logic underdetermines *R*; clusters of convergence $\approx$ incommensurable wv's + tension betw them at SRS CAB improved ER and nuclear waste mgt decisions (i.e., DC's):
    - **SRS CAB: maj. rule d.m. + min. rpts ($\Delta a \rightarrow 0$)**
      - » **SAB: + internal conflict, + mbr liking**
    - **HAB: consensus rule d.m. ($\Delta I \rightarrow 0$)**
      - » **HAB: + external conflict, - mbr liking**
  - **National Airspace System**

Case i: $\Delta I \rightarrow 0, \Delta a \rightarrow \infty$

- 125 USAF combat pilots in eight 3-min ACM encounters against machines and human. *K* of air combat = multiple-choice exam. Experience = flight-time histories + training.
- Multiple regressions => experience predicted wins-losses ($\underline{R}$=.34, $\underline{p}$<.03), total aircraft relative E availability ($\underline{R}$=.37, $\underline{p}$<.01), and expert rating of performance ($\underline{R}$=.47, $\underline{p}$<.0001).
- ***K* did not predict wins-losses, *E* availability, or expert ratings** ($\underline{R}$=0.0, $\underline{p}$ n.s.). (Lawless et al., 2000a)

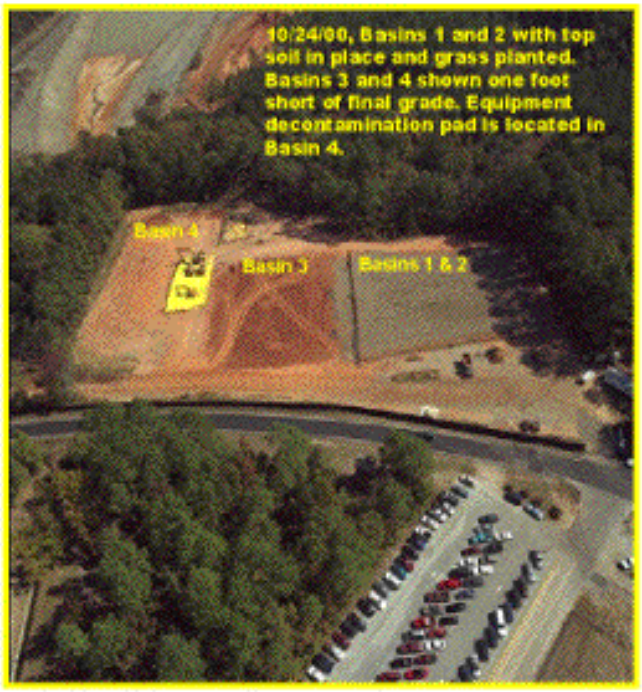
Case ii: $\Delta a \rightarrow 0, \Delta I \rightarrow \infty$



SRS along the Savannah River, Eastern USA

Contaminated Soils

Remediated


10/24/00, Basins 1 and 2 with top soil in place and grass planted. Basins 3 and 4 shown one foot short of final grade. Equipment decontamination pad is located in Basin 4.
Basin 4
Basin 3
Basins 1 & 2

SRL basins before-after CAB (DC) saved 2 years on environmental cleanup -> plug-in-rods (i.e., *idp*'s -> *wdp*'s)

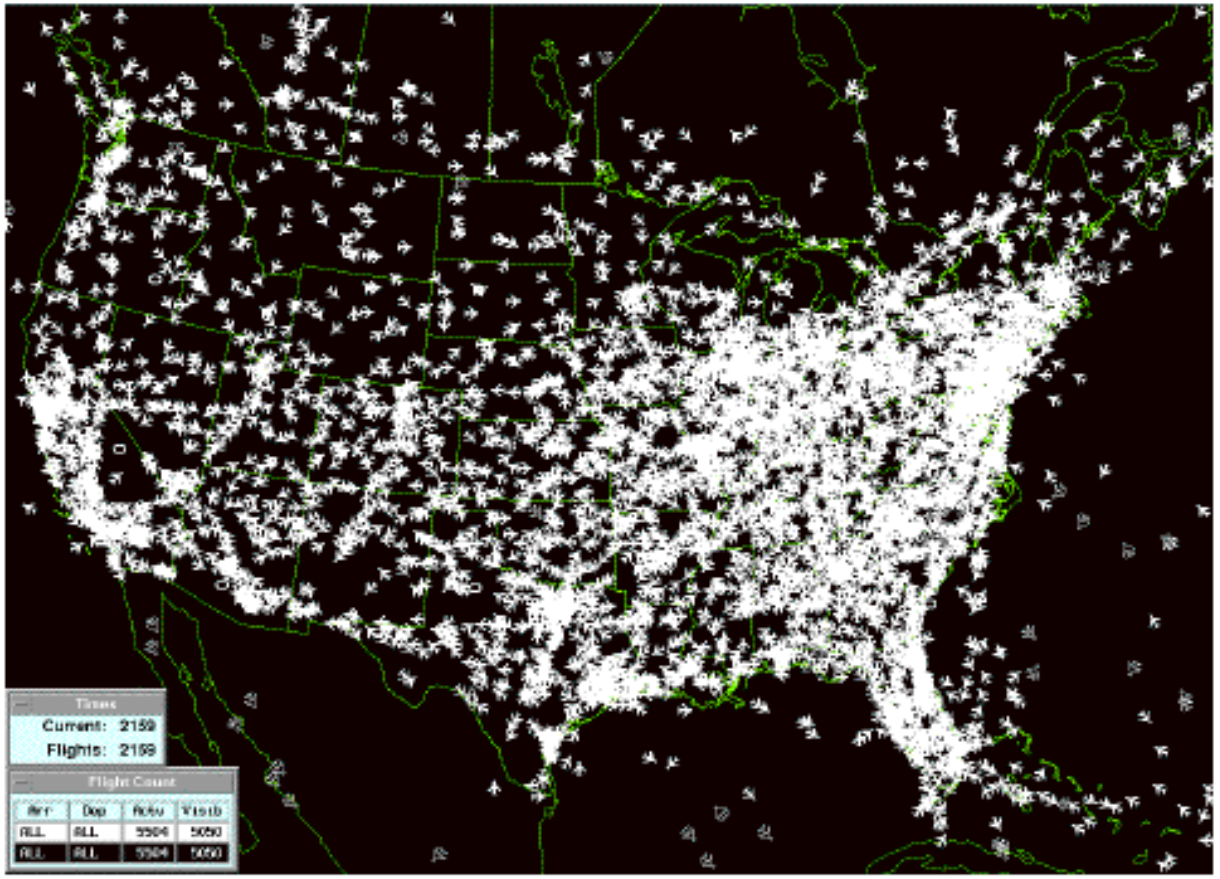
DWPF/GWSB

New Engineered Trenches

F&H and LLW-BG

2 HLW tanks closed, 1200 cans (Lawless et al., 2000a)

Case ii: $\Delta a \rightarrow 0$, $\Delta I \rightarrow \infty$ (National Airspace System)



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Convection Weather = Single most disruptive force within NAS

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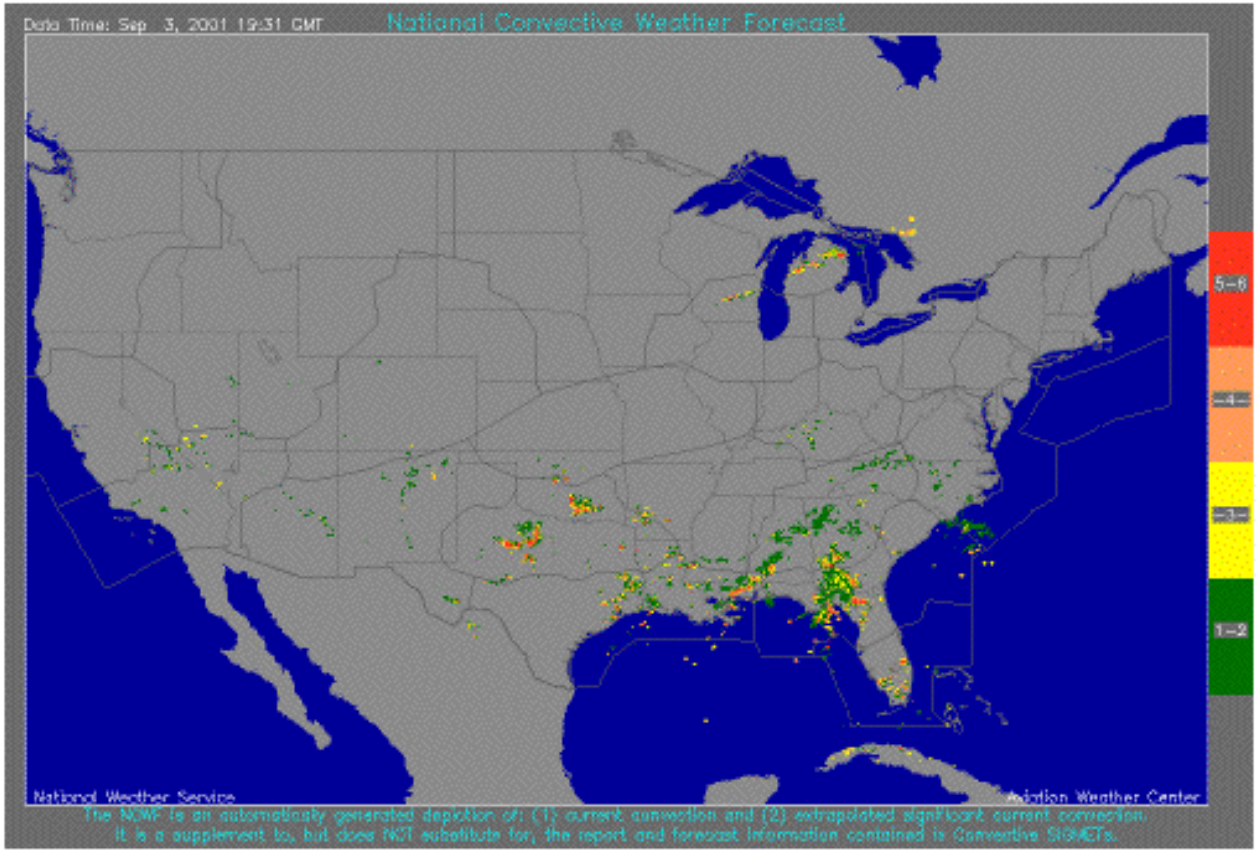
NCWF: Automated Forecast


Data Time: Sep 3, 2001 19:31 GMT
National Convective Weather Forecast
5-6
4
3
1-2
National Weather Service
Aviation Weather Center
The NCWF is an automatically generated depiction of: (1) current convection and (2) extrapolated significant current convection.
It is a supplement to, but does NOT substitute for, the report and forecast information contained in Convective SIGMETs.

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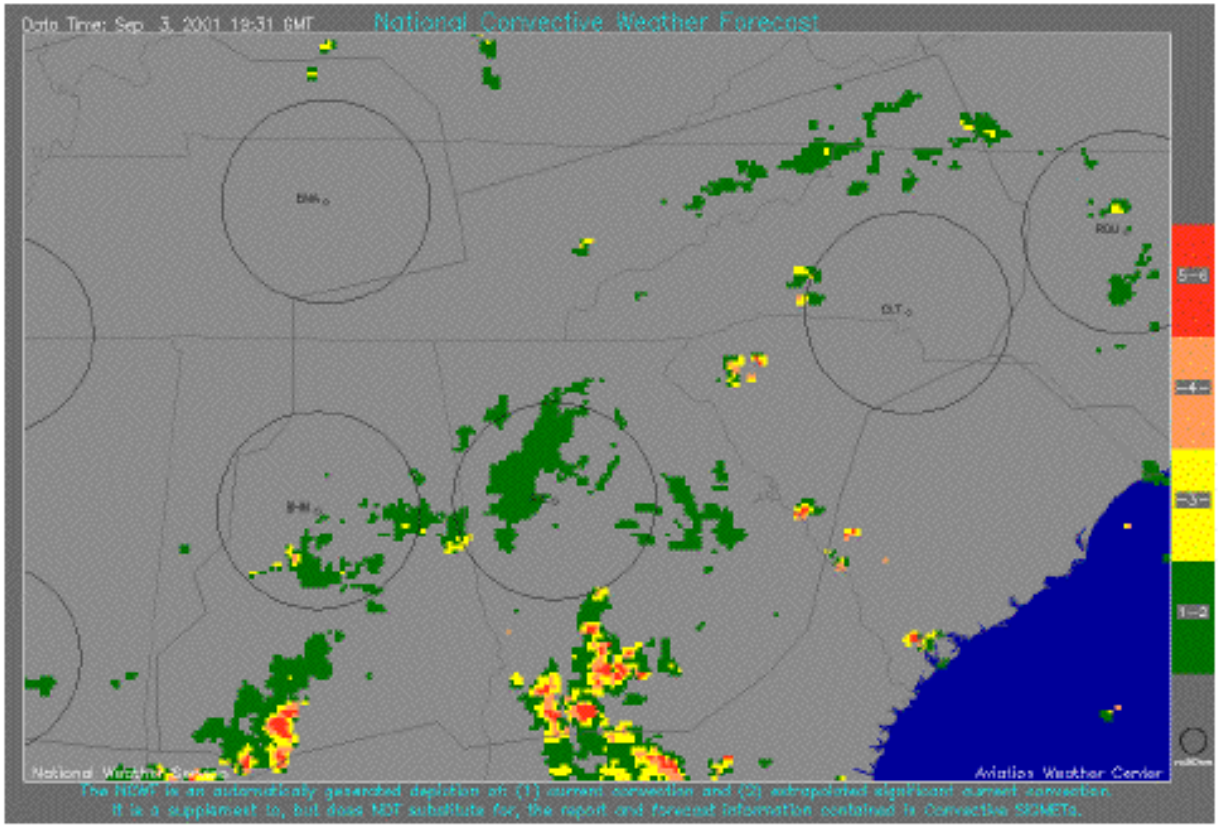
NCWF: Convective Cells



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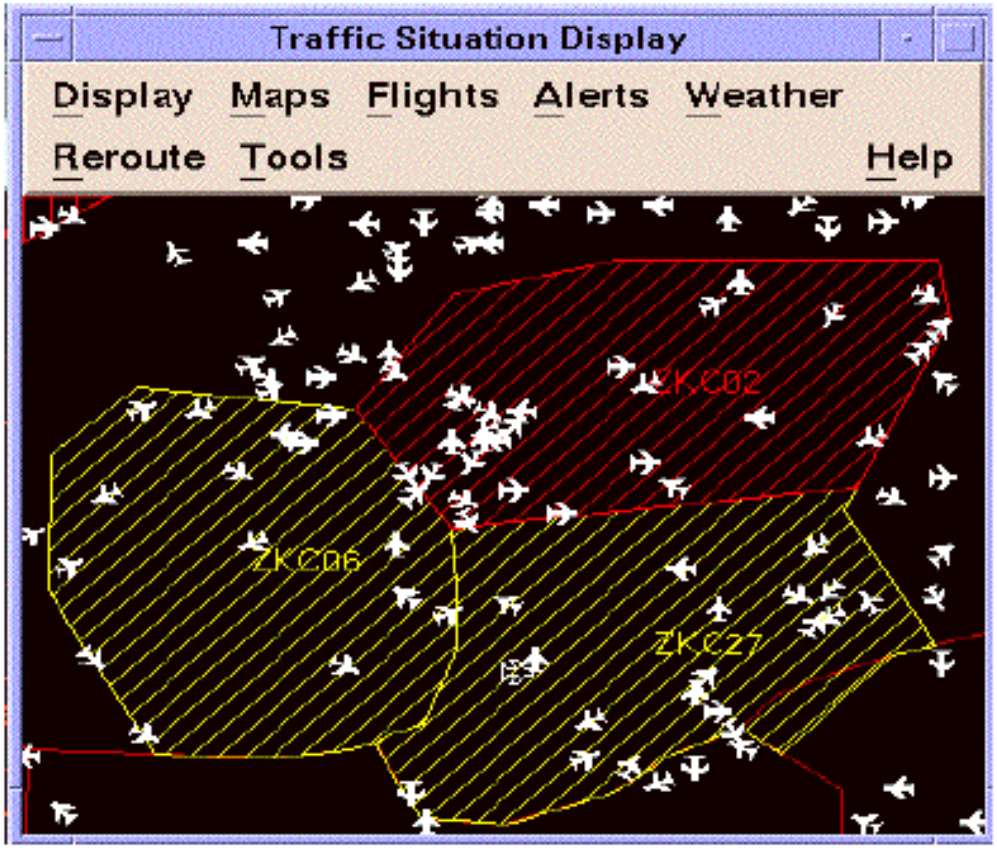
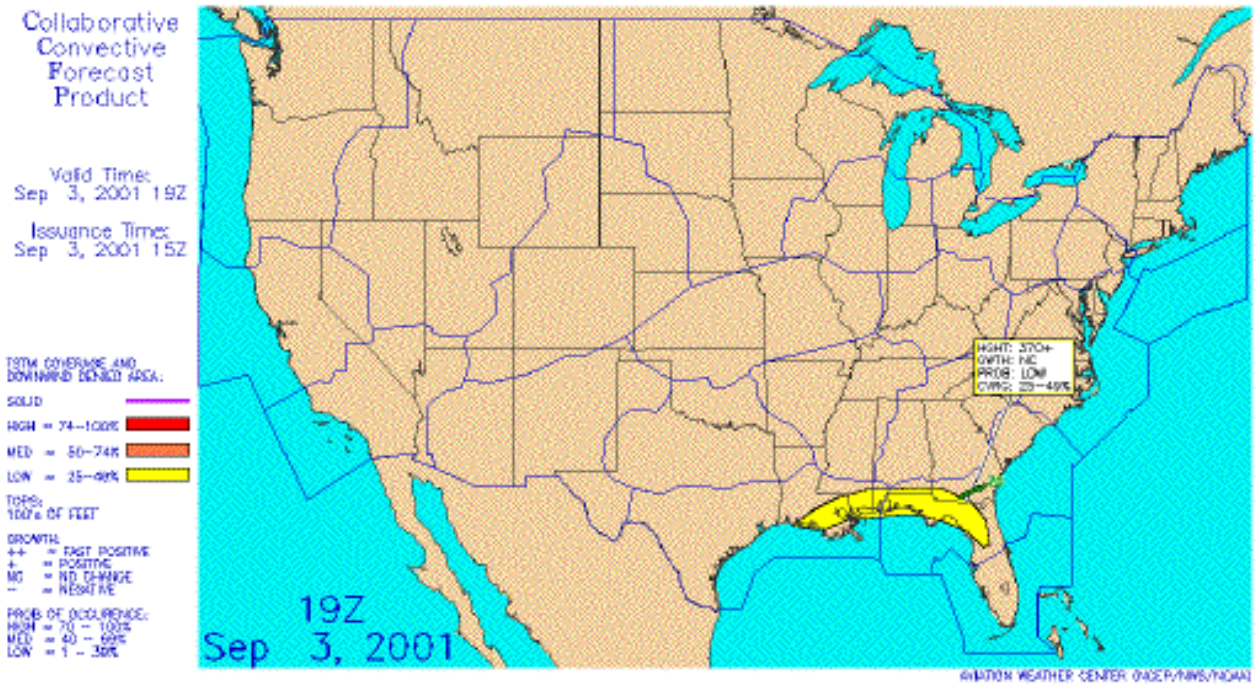
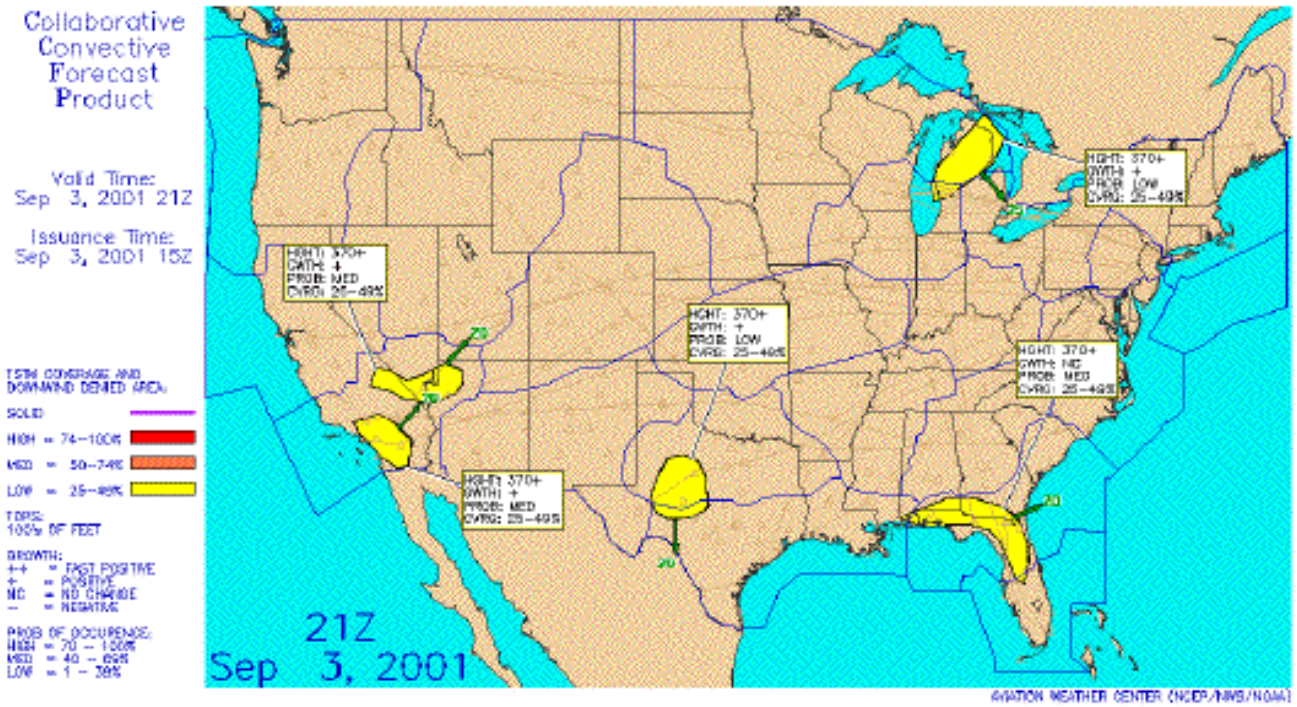
Traffic Situation Displays



CCFP: 19Z, Sep 3, 2001



CCFP: 21Z, Sep 3, 2001



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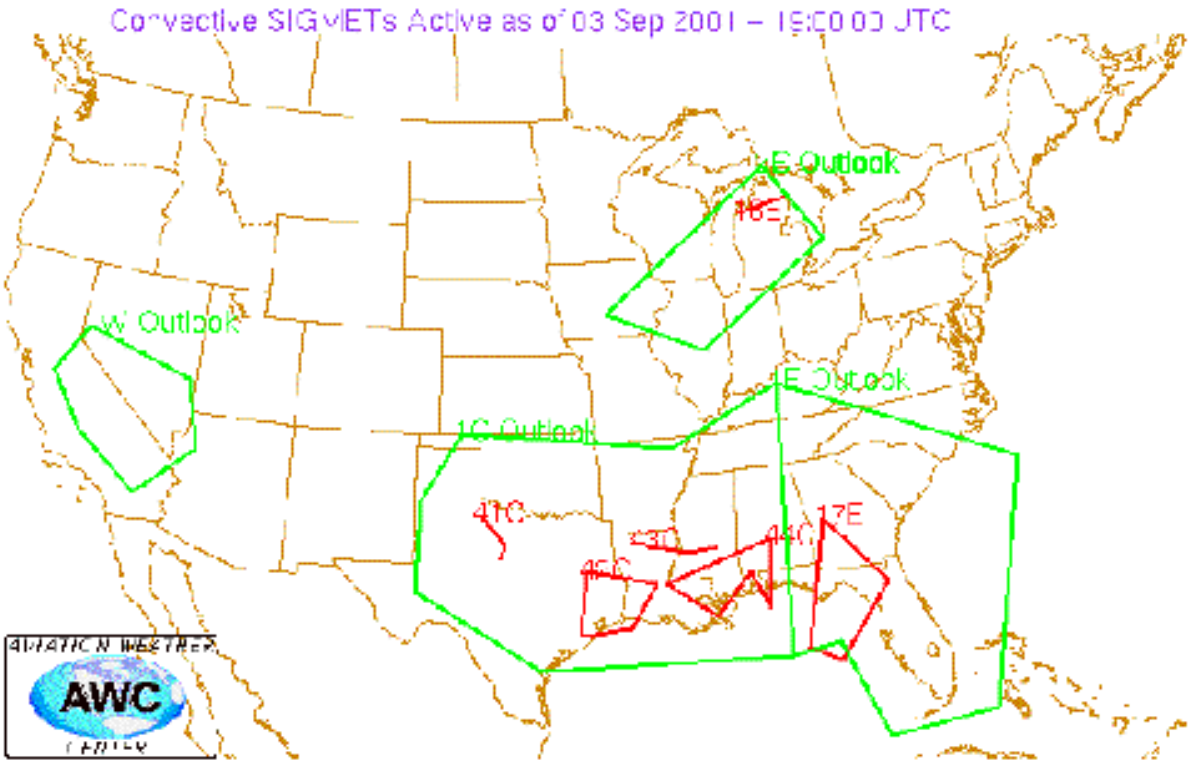
SIGMET Outlook (Convection)



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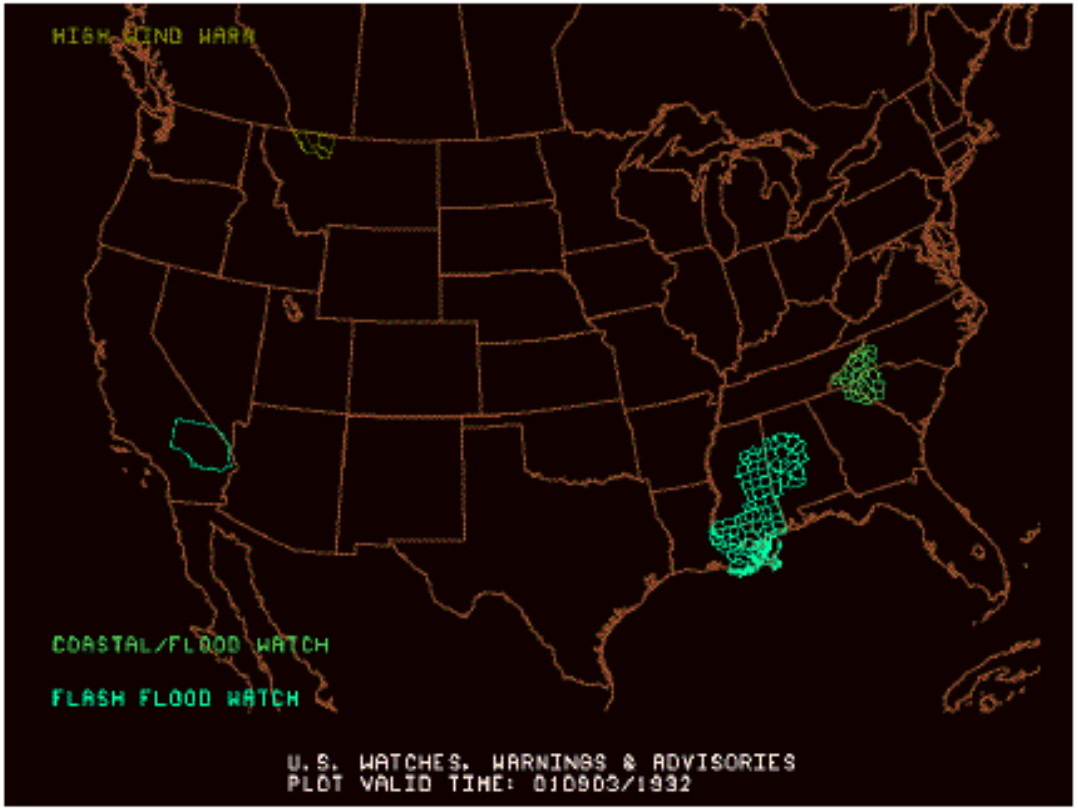
Watches, Warnings, & Advisories



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RTVS (FAA's FSL)

Product	Issued (UTC)	Forecast Length	Human/ Automated	Ave area Forecast covered	Average PODy	FAR	Bias
CCFP	1500, 1900	1,3,5 and 3,5,7 h	H	5.2%	.28	.84	1.9
Convective SIGMET	Hourly	1,2 and 0-2 h	H	2.3%	.28	.70	1.0
SIGMET Outlook	Hourly	2-6 h and 6 h	H	14.9%	.04	.92	6.1
NCWF	5 min	1 and 2 h	A	0.5%	.09	.41	.10

Table 1. In this table, better forecasts have a lower convective area covered by the forecast, a greater PODy, a lower FAR, and a Bias closer to one (bias greater than one over-predicts convection; less than one under-predicts). [SIGMET is significant meteorological information; NCWF is the automated computer generated numerical prediction; POD-y is the probability of a forecast being observed = Y(forecast)Y(observed)/(YY+NY); FAR is the false alarm ratio = YN/(YY+YN); and Bias is the tendency to over or under predict convection = (YY+YN)/(YY+NY).]

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Results

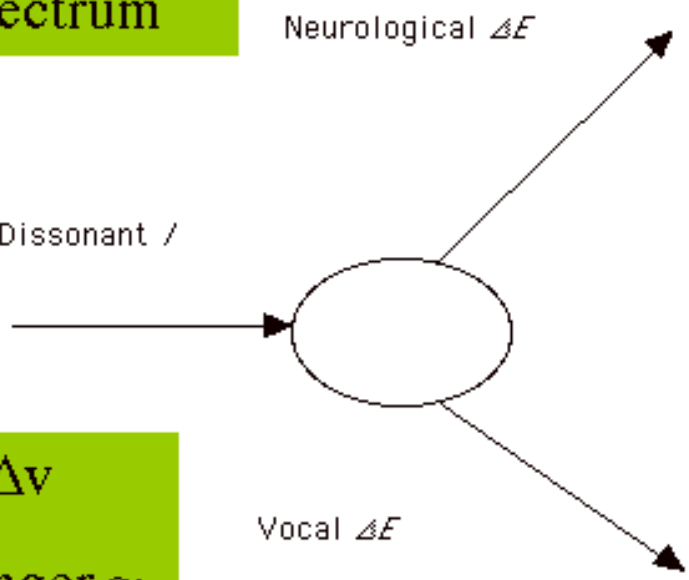
- **METOC: 6 sessions at sea, 74.3 msgs, 10.7 wx, 5.3 shared agreements, 0.63 disagreements**
- **CCFP (1998): 88.9% believe accurate; 92.6% good tool**
- **CCFP (1999): 15.2 collaborations/product; 19.63 msgs; 6.5 iterations; 5.76 expressed agreements, 0.52 disagreements; 49.8 min sessions; 79% believe accurate;**
- **DOT (2000-2001): 6% improved ontime arrivals**
- **ER: sign. disagreement, quicker & better decisions, + liking (SAB v. HAB)**

Collaboration Conclusions

- DC => bistable *R* => best d.m. from orthogonal operators (**"competition of ideas"**), multiple convergences, spontaneous consensuses, dissonance arousal sufficient to produce and process *I*
- Resonance tunnels thru social barriers (**"compromise"**)
- Converts *idp*'s to *wdp*'s ≈ *K* or technology
- Optimum: $I_R = f(1/(max\ emotional\ agitation\ that\ preserves\ cooperation - min\ competition\ that\ precludes\ social\ loafing))$

Future Research

Picard: Liquid model of Emotion -> Spectrum



$\Delta E \approx h * \Delta v$

(Hameroff: 2E6 Neurons ≈ 40 Hz, gamma)

$\Delta E \approx h * \Delta v$

(Kang: Anger ≈ + 100 Hz)

Additional Reading

Lawless, W.F. (2001). The quantum of social action and the function of emotion in decision-making, Emotional Agent II. The Tangled Knot of Cognition, AAAI Fall Symposium, Cape Cod, MA, November 2, 2001.

Lawless, W.F. & Castelao, T. (2001), The University as Decision Center, IEEE Technolgy and Society Magazine (special issue: University as Bridge Between Technology and Society), 20(2), 6-17.

Lawless, W.F., Castelao, T., & Abubucker, C.P. (2000), Conflict as a Heuristic in Development of Interaction Mechanics, In C. Tessier, H.J. Muller, & L. Chaudron, Conflicting agents: Conflict mgt in multi-agent systems, pp. 279-302, Boston: Kluwer).

Lawless, W.F., Castelao, T., & Ballas, J.A., (2000), Virtual knowledge: Bistable reality and solution of ill-defined problems, IEEE Systems, Man, & Cybernetics, 30(1), 119-124).